

Specification Amendments:

Page 6, Lines 9 and 10:

Figs. 6 and 7 are longitudinal and transverse cross sectional and elevational views showing a component of the system of Fig. 4.

Paragraph bridging pages 9-11:

Fig. 4 shows in cross section a catheter 12a with a preferred tube structure for providing multiple lumens in both inflow and outflow directions. In this form of catheter structure, the outer tube 46a and inner tube 40a, both extrusions, are fitted closely together to define, dividing the annular space between the two extrusions into 48a, 48b, 48c and 48d. In the form shown, the outer extrusion 46a is formed essentially as a simple cylinder, while the inner extrusion 40a has ridges 54 on its exterior which, when the inner extrusion 40a is pulled into the outer extrusion 46a, engages firmly against the inner wall of the outer extrusion 46a. This centers the inner extrusion within the outer extrusion while also defining the plurality of lumens 48a-48d around the circumference of the catheter as shown. The multiple lumens could thus be used for different purposes, if desired, but in a preferred embodiment they are all used to carry inflowing coolant liquid toward the

end of the catheter. An important feature provided by this construction is that of assuring flow even if the catheter is bent to the point of creasing or kinking one side. Thus, if the catheter goes through a very tight bend and a kink develops at the lumen 48c, for example, the remaining lumens, or at least some of them will remain open and will continue delivering the necessary coolant liquid. It should be understood that the ridges 54 can be provided either on the outer surface of the inner extrusion ~~48a~~ 40a (as shown) or on the inner surface of the outer extrusion 46a. They could be provided on both surfaces if desired, in spaced and alternating relationship, although it is sufficient to provide them on one surface or the other.

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Figs. 6 and 7 also show this "shower head" or liquid distribution head 58a in a somewhat different form. In Figs. 6 and 7 the distribution head 58a is shown as a wall 64 with orifices 60, and a distal portion 65 in the distal direction of the wall and a proximal portion 66 proximal to with respect to the wall 64. The distal portion 65 forms a chamber or area 70 into which the coolant liquid flows from the flow lumen 48 shown in Fig. 5 (after reversing direction), and it defines a coolant exit area 71 downstream of the orifices 60. Preferably a series of centering prongs 72 are included on this distal end for

engaging against the end of the cooling tube 46a to retain and center the x-ray tube and the shower head 58a in place in the tube, allowing for distribution of coolant. Fig. 7 shows the coolant distribution head 58a in end view, showing the centering projections 72 and orifices 60. Relatively few orifices 60 are shown in these drawings; preferably there are at least three, more if needed for uniformity. The orifices need to be sized to create appropriate impedance to produce the back pressure discussed above.

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As shown in Fig. ~~10~~ 11, the configuration is different closer to the x-ray tube 38, where the balloon 85 is included. Here, the balloon ~~84~~ 85 forms not only the outer wall of the applicator, but forms the inflow lumen 96 in this region, between the balloon and the outer surface of an extrusion 98. This extrusion 98 may be formed as shown, with internally extending ridges 99 which engage firmly against the outside surface of the x-ray source 38. The outflow lumens are shown at 92a in this region. Downstream of the source, i.e. the x-ray tube 38, the situation is different and the outflow lumens 92a merge into a single space surrounding the control cable shaft 44, which is smaller in diameter than the radiation source 38. This return flow or outflow space is sealed to the proximal extrusion 88 such

that the outflow space within the extrusion 98 connects directly and in sealed relationship with the outflow channels 92 in the proximal extrusion 88. At this point, i.e. the position 86 shown in Fig. 9, the inflow lumens 90 are sealed off, and radial openings are provided to communicate this space with the space 96 within the balloon 85.

Page 18, Paragraph bridging pages 18 and 19:

Fig. 13 shows another configuration for the applicator end of the catheter, providing inflow and outflow lumens for coolant. As in Fig. 11, an external balloon 94 is attached to surround an extrusion 110. In this form, however, to reduce catheter size the distal extrusion 110 can be shaped as shown. Note that the extrusion ~~100~~ 110 is not circular, but is flat or even grooved inwardly at a series of locations, preferably three or four or more, as shown at 112 in Fig. 13. These locations 112 are at the same angular positions as bumps or ridges 114 formed on the inner side of the extrusion, these ridges 114 engaging against the outside surface of the radiation source 38 as in above described embodiments. The balloon 94 is sealed to the exterior of the extrusion 112 at the distal end, and is sealed to an adjacent proximal extrusion near the proximal end, in the same manner as in Fig. 9. When the catheter is inserted into a vessel or lumen of the patient, the user applies a vacuum to the inlet and outlet ports of the cooling system, at the proximal end of the catheter.

This not only maintains the balloon 94 tight against the outside of the extrusion 110, but also pulls the outflow/return lumens 116 inwardly, into contact with or nearly into contact with the radiation source 38, considerably reducing the size of the applicator at the distal end of the catheter. As above, when the coolant is introduced under pressure, this will dilate the lumens, both inflow and outflow, to the flow area needed.